



EXAMINED UTILITY MODEL PUBLICATION NO. 48-7051

**TRANSPARENT SCREEN**

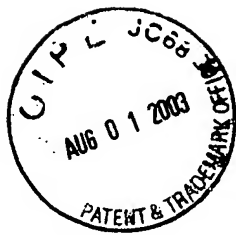
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TRANSPARENT SCREEN

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[There are no amendments.]

## Specification

Title of the design

Transparent screen

Brief description of figures

Fig. 1 is a partial enlarged cross-section view showing the shape of the transparent screen cross-section of the present design, Fig. 2 is a graph that shows the relationship between transmittance  $T$  and diffusion angle  $\theta$  of the transparent screen of the present design, and Fig. 3 is a graph that shows the results of measurement of the transparent screen of the present design.

Detailed description of the design

The present design pertains to an improvement of transparent screens capable of providing a wide-angle light diffusion property while good image-formation and a bright screen are retained, through arrangement of a fine particle non-reflective surface on one side of a diffusion sheet made of a thin plastic material with a light diffusion material uniformly mixed in it and forming a wave-like lenticular pattern on the other side.

The present design is explained in further detail with the drawings below. In Fig. 1, 1 is transparent screen produced by forming a fine particle non-reflective surface 3 on one side of a sheet-like diffusion layer 2 made of a thin plastic material with a light diffusion material, such as anhydrous magnesium silicate, uniformly mixed in it to form a light transmittance of approximately 60% and forming a lenticular surface 4 with lenses having identical radii of curvature that inflect at a specific interval on the other side in the direction perpendicular to the screen (horizontal direction in the fig.) to form a wave-like pattern.

In the screen having the above-mentioned structure, when one of lenticular lenses 4 is regarded as a convex lens, the angle of incidence of light that enters the spherical surface  $v_1$  from the projector is  $\beta$ , the radius of curvature of the spherical surface of the lenticular surface 4 is  $r$

and the pitch of the lenticular surface is  $P$  as shown in Fig. 1,

$$\sin \beta = P/2r$$

and the value obtained is defined as  $K$ . The angle formed by the exit beam of light having a height  $h$  for the  $v_1$  surface of the lens and parallel to the optical axis and the optical axis is defined as  $\theta$  and is used as the diffusion angle. In the same manner, when the diffusion angle for the angle of incidence for height  $h + \Delta h$  is defined as  $\theta'$ ,  $\Delta\theta = |\theta' - \theta|$  can be achieved, and furthermore, when the quantity of light at the angle of incidence of height  $h$  per unit height is defined as  $I(h)$ , the quantity of light of the exit beam per unit value is defined as  $I'(\theta)$ , and transmittance is defined as  $T$ , the relationship shown below can be established between the quantity of light entering through the interval  $\Delta h$  and the quantity of light exiting at an angle of  $\Delta\theta$ .

$$I(h) \cdot \Delta h \cdot T = I'(\theta) \cdot \Delta\theta$$

Therefore,

$$I'(\theta) = I(h) \cdot T \cdot (\Delta h / \Delta\theta) \dots\dots\dots (1)$$

Based on the relationship shown above, for example, when vinyl chloride is selected as a material for the diffusion layer, the relationship between the transmittance  $T$  and diffusion angle  $\theta$  for  $K$  with a refractive index of 1.5 is shown in Fig. 2. In this case, the concave lens is the same as the convex lenticular surface when the radius of curvature of the spherical surface is  $r$  for the concave surface of the lenticular surface.

It is desirable when a bright and clear image is obtained at an angle of view of at least 15 to 20 degrees in the vertical direction and approximately 35 to 40 degrees in the horizontal direction of the projection screen, and in order to obtain an optimum screen within the above-mentioned practical angle of view, for example, in order to achieve diffusion angle  $\theta$  of 37 degrees,  $K=0.85$  is obtained from equation (1) or Fig. 2.

On the other hand, the beam of light that travels along the optical axis of the lenticular

surface advances directly inside the diffusion layer and is identified as a bright light by the viewer and projection performance is inhibited; thus, it is necessary to establish the pitch of the lenticular surface at an appropriate degree. In general, the visual limit of distinguishing two lines accurately is  $20''$ , thus, when the distance between the screen and the viewer is  $L$  m/m,  $P = L \times 0.000097$  (rad) = approx.  $L \times 10^{-4}$ . Therefore, in order to achieve an optimum screen at an angle of view of 37 degrees and distance between the screen and viewer of 2 m, a lenticular pitch of  $P=0.2$  mm and radius of curvature of  $r=0.12$  mm are suitable.

[p. 2]

Fig. 3 is a graph where a vertical incident beam of light is applied to the screen, and the angle of the transmitted light in the same direction as the incident light is defined 0 degrees and the angle of light on a flat surface that includes transmitted light of angle  $0^\circ$  is changed from  $0^\circ$  to  $50^\circ$  and the quantity of light at each angle is measured and the quantity of light at  $0^\circ$  angle is shown as 100; curve A shows the characteristic in the horizontal direction of the screen and curve C shows characteristic in the vertical direction of the screen.

According to the present design, a significant increase in the diffusion property in the horizontal direction of the screen is possible based on the specific shape of the lenticular surface, and a narrow angle of view is required in the vertical direction; thus, the mixing ratio of the diffusion material can be reduced, and the thickness of the diffusion layer can be reduced, and a transparent screen having excellent light transmittance and good image-formation properties with an absence of nonuniform colors can be produced.

#### Claim of the design

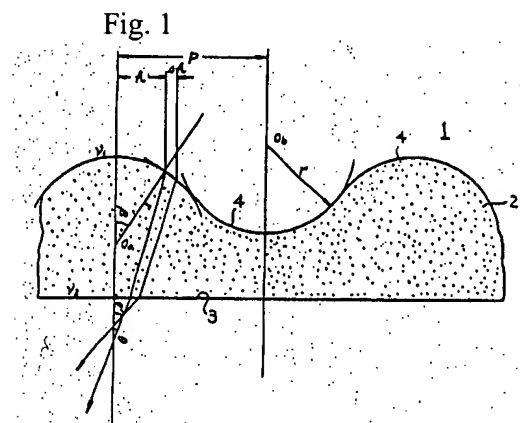
A transparent screen produced by forming a wave-like pattern having identical radii of curvature on one or both surfaces of a sheet-like diffusion layer made of a thin plastic material with a fine diffusion material uniformly mixed in so as to form light transmittance of

approximately 60%, and a non-reflective surface of fine particles is formed on the other surface and having a lenticular wave-like pattern of  $K = 0.3$  to  $0.9$  and  $P \text{ approx.} = L \times 10^{-4}$  when the ratio of the pitch of the aforementioned lenticular surface  $P$  (mm) and the radius of curvature  $r$  (mm) is  $p/2r=K$  and the distance between the screen and viewer is  $L$  (mm).

## References cited

JP Sho 28-1528 (J, U)

British Patent No. 969071



[p. 3]

Fig. 2

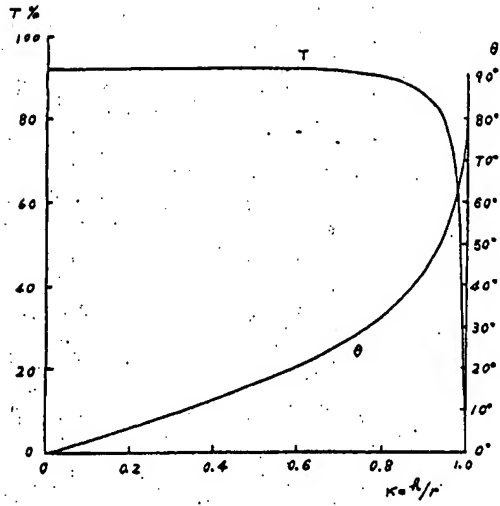
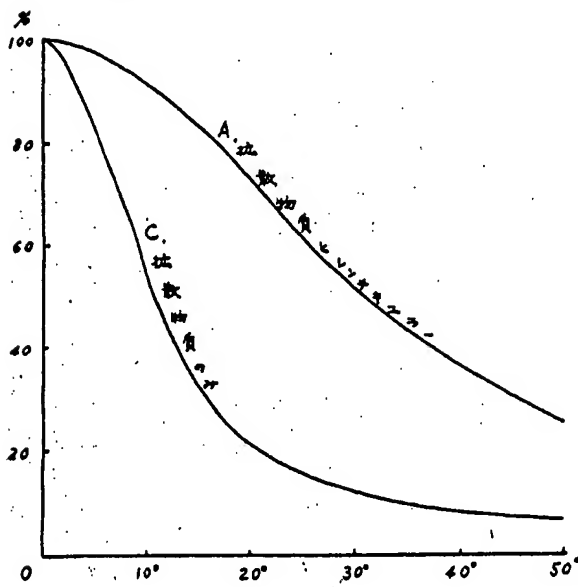


Fig. 3



Vertical axis: diffusion quantity of light

Horizontal axis: Angle

A: Diffusion material and lenticular surface

B: Diffusion material alone